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KM3NeT's sensitivity to the next core-collapse supernova

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Core-collapse supernovae (CCSNe), the explosions marking the end of a massive star's life cycle, are of immense interest in astrophysics but their underlying mechanism is not completely understood yet. Given the high density and opacity of the star's core, neutrinos emerge as the most promising probe for unravelling the CCSN dynamics. However, such neutrinos would be detected only if a supernova takes place in our Galaxy or its neighbourhood. Since close-by CCSNe are rare and unpredictable, it is necessary to maximize the detection potential of all sensitive neutrino experiments. We present an updated CCSN search strategy using the KM3NeT neutrino detector.

KM3NeT, currently being deployed in the Mediterranean Sea, was initially designed for the detection of GeV to PeV neutrinos. However, its spherical digital optical modules (DOMs), equipped with 31 photomultipliers oriented in various directions, can be used as standalone detectors for MeV-scale CCSN neutrinos. To identify these neutrinos, we defined new observables that characterize the geometry of events on single DOMs. These observables allow discerning low-energy neutrino events associated with CCSNe from radioactive decays in seawater and atmospheric muons. We will present the sensitivity of KM3NeT's current and final detector configurations to the next close-by CCSN, using the single-DOM observables to maximize the signal-to-noise ratio. In addition, we will show how to parameterize the variations of the expected background level with the data-taking conditions. This parameterization is essential to search for CCSNe automatically with KM3NeT's Real-Time Analysis Platform.

Poster prize

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